Chapter 12: Fundamentals of the Nervous System and Nervous Tissue

- Overview of the NS
  - PNS (Peripheral Nervous System)
  - CNS (Central Nervous System)
- Neurons
- Neuroglia
- Synapse
- Some nomenclature

Developed by
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LAS POSITAS COLLEGE

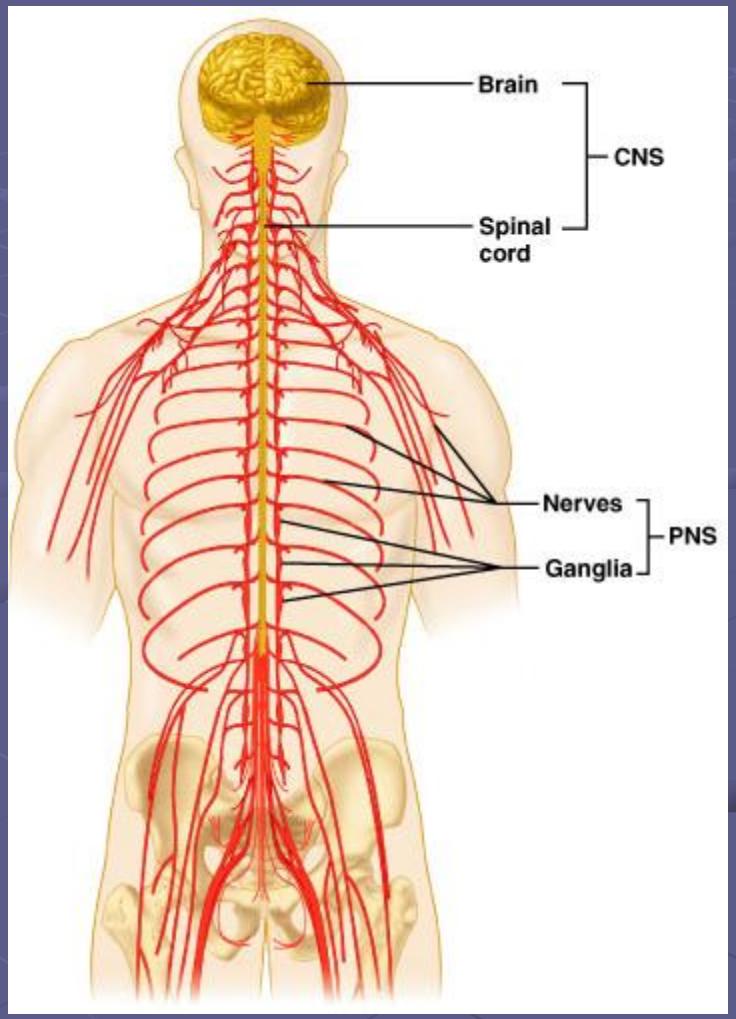
Functional Overview of NS

CNS = Brain and Spinal Cord

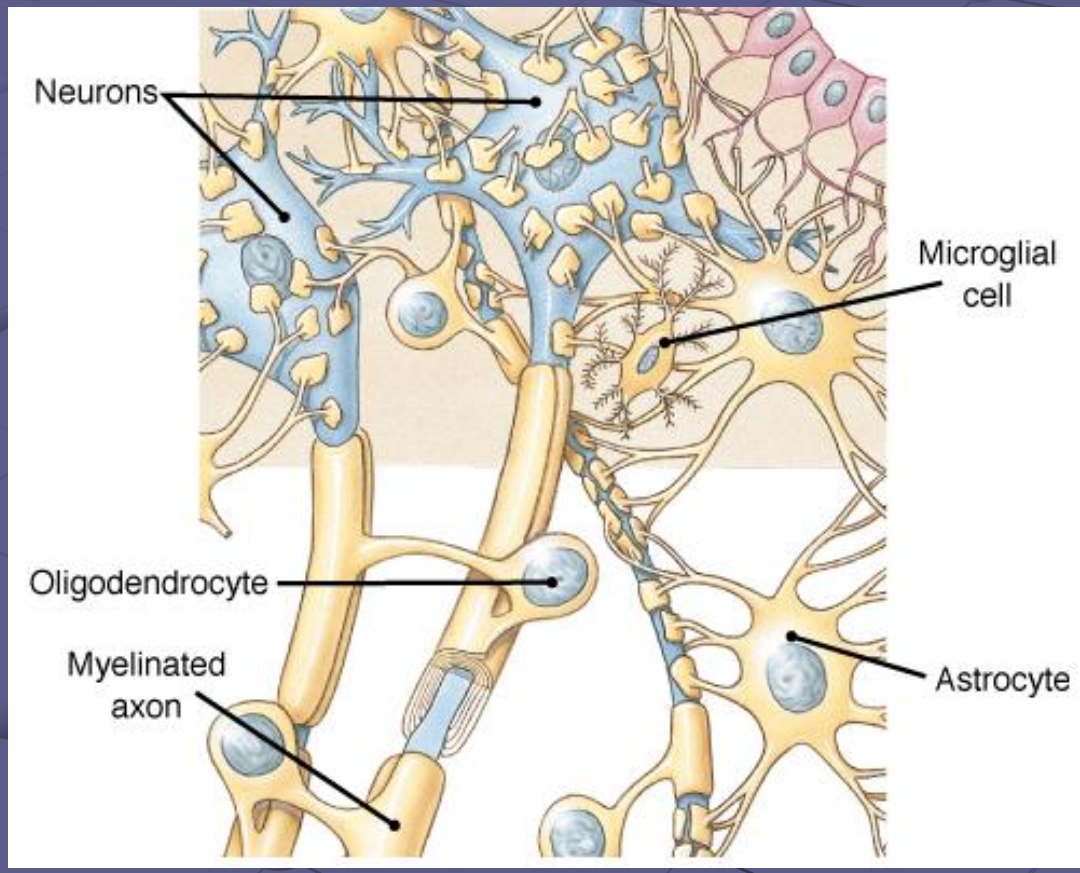
- Integration, processing and coordination of sensory data and motor commands
- Higher functions

PNS

1. Sensory or afferent division
   with sensory neurons.
   Brings sensory info from PNS to CNS.
   Begins at receptors
2. Motor or efferent division
   with motor neurons.
   Brings motor commands to peripheral tissue.
   Ends at effector cells.



Made up of neurons and neuroglia



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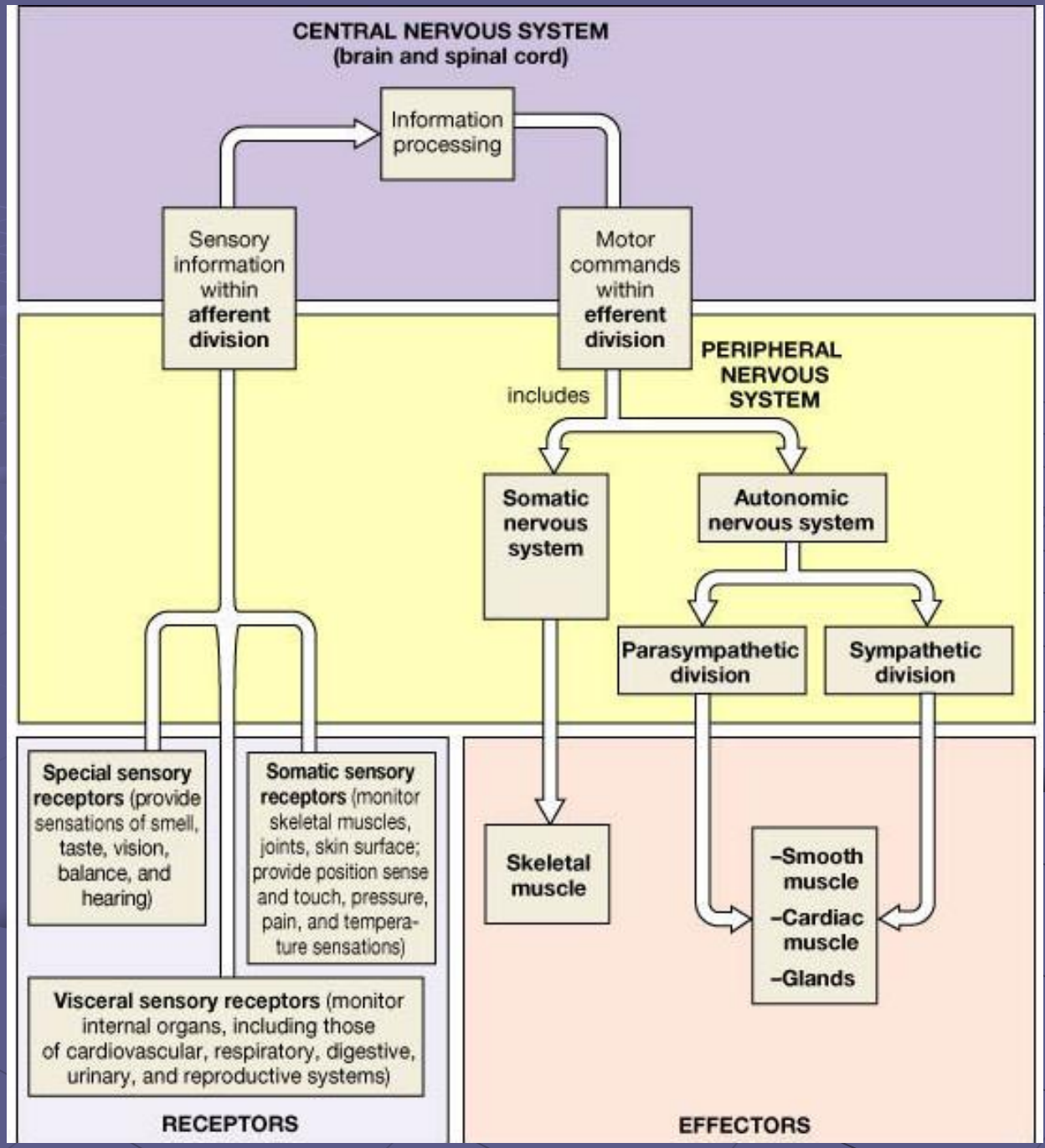
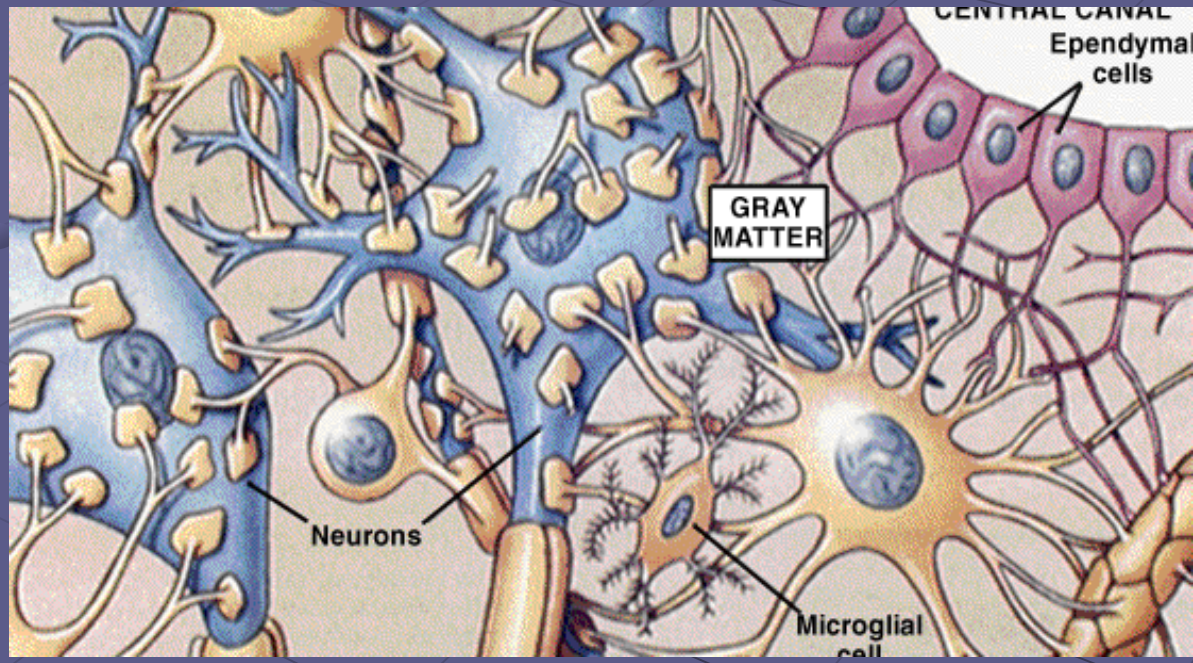

CENTRAL NERVOUS SYSTEM
(brain and spinal cord)
Information processing
Sensory information within afferent division
Motor commands within efferent division
PERIPHERAL NERVOUS SYSTEM
includes
Somatic nervous system
Autonomic nervous system
Parasympathetic division
Sympathetic division
Special sensory receptors (provide sensations of smell, taste, vision, balance, and hearing)
Somatic sensory receptors (monitor skeletal muscles, joints, skin surface; provide position sense and touch, pressure, pain, and temperature sensations)
Visceral sensory receptors (monitor internal organs, including those of cardiovascular, respiratory, digestive, urinary, and reproductive systems)
Skeletal muscle
–Smooth muscle
–Cardiac muscle
–Glands
RECEPTORS
EFFECTORS

Cellular Organization of Neural Tissue

Two cell types:

1. Neurons
    1. "Excitable" cells
2. Neuroglia (mostly not excitable)
    - Schwann cells
    - Satellite cells
    - Astrocytes
    - Oligodendrocytes
    - Microglial cells
    - Ependymal cells



1. Typical Neuron Structure

- Cell body or Soma with Perikaryon
- Dendrites
- Axon with axon hillock
- Synaptic terminals

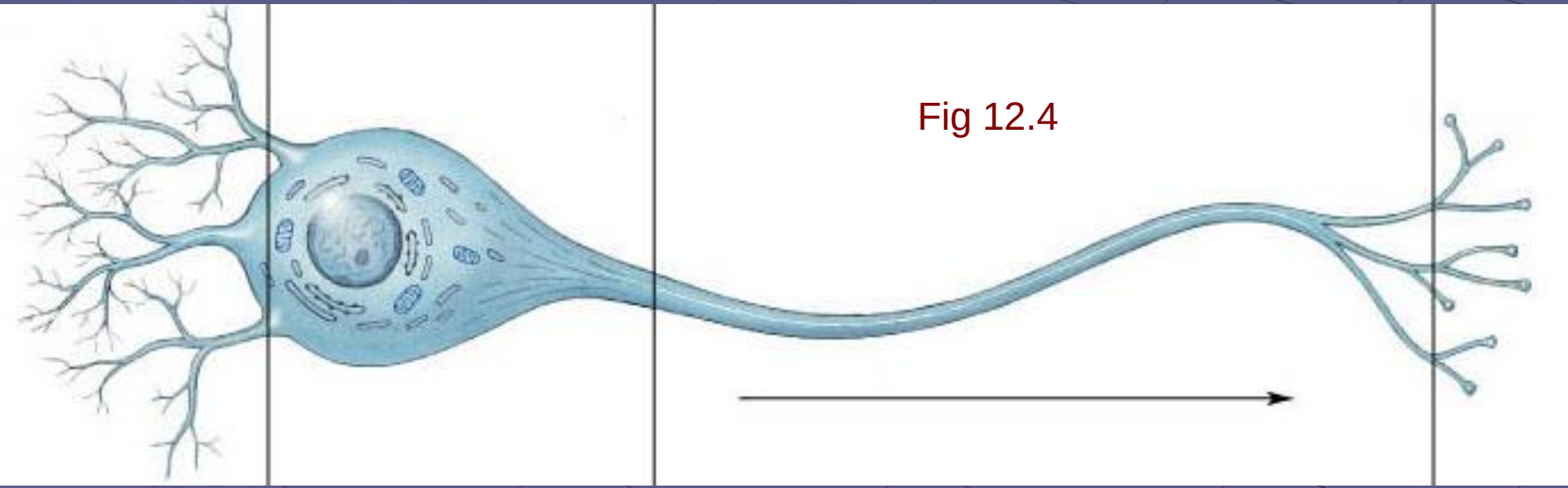
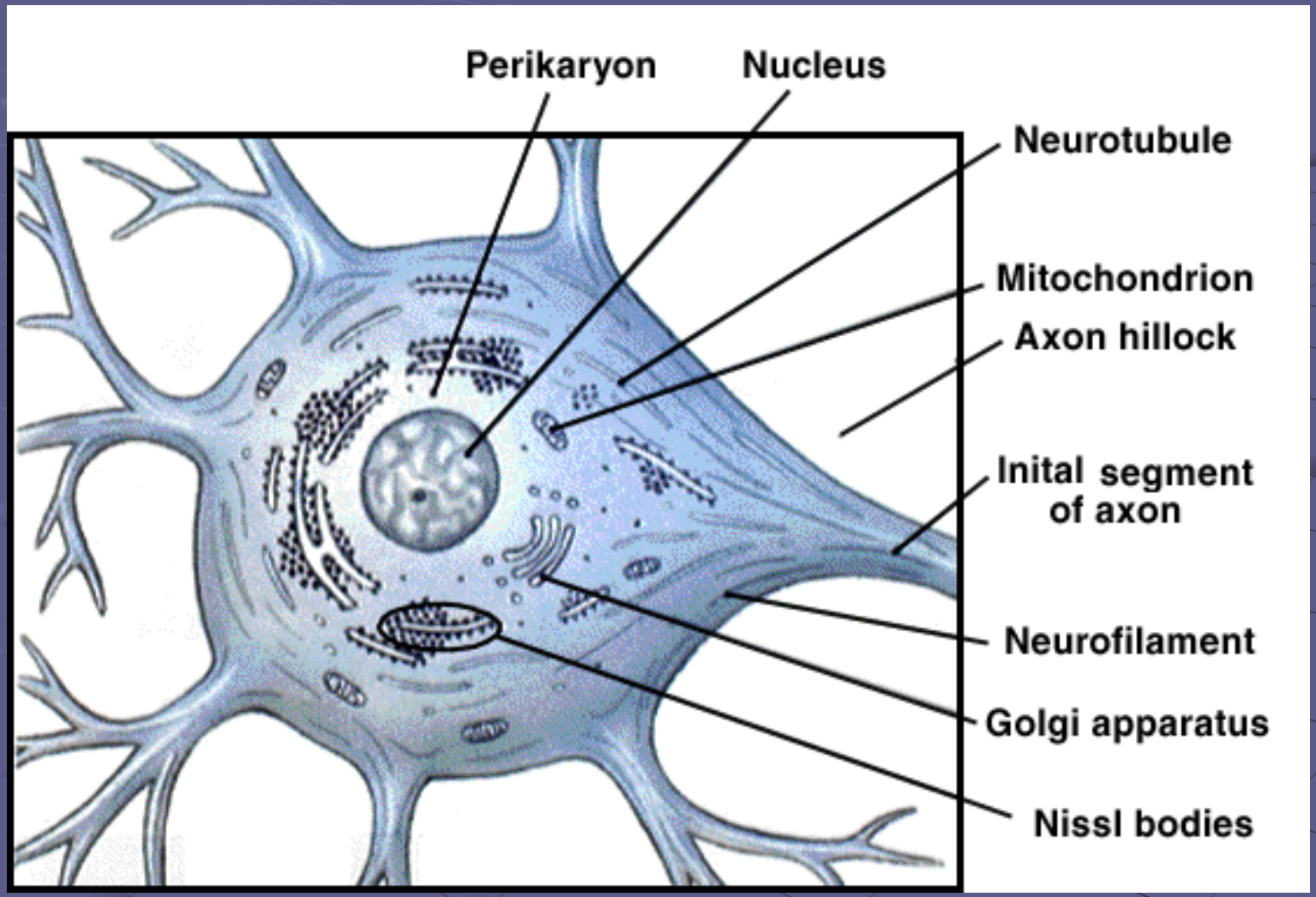
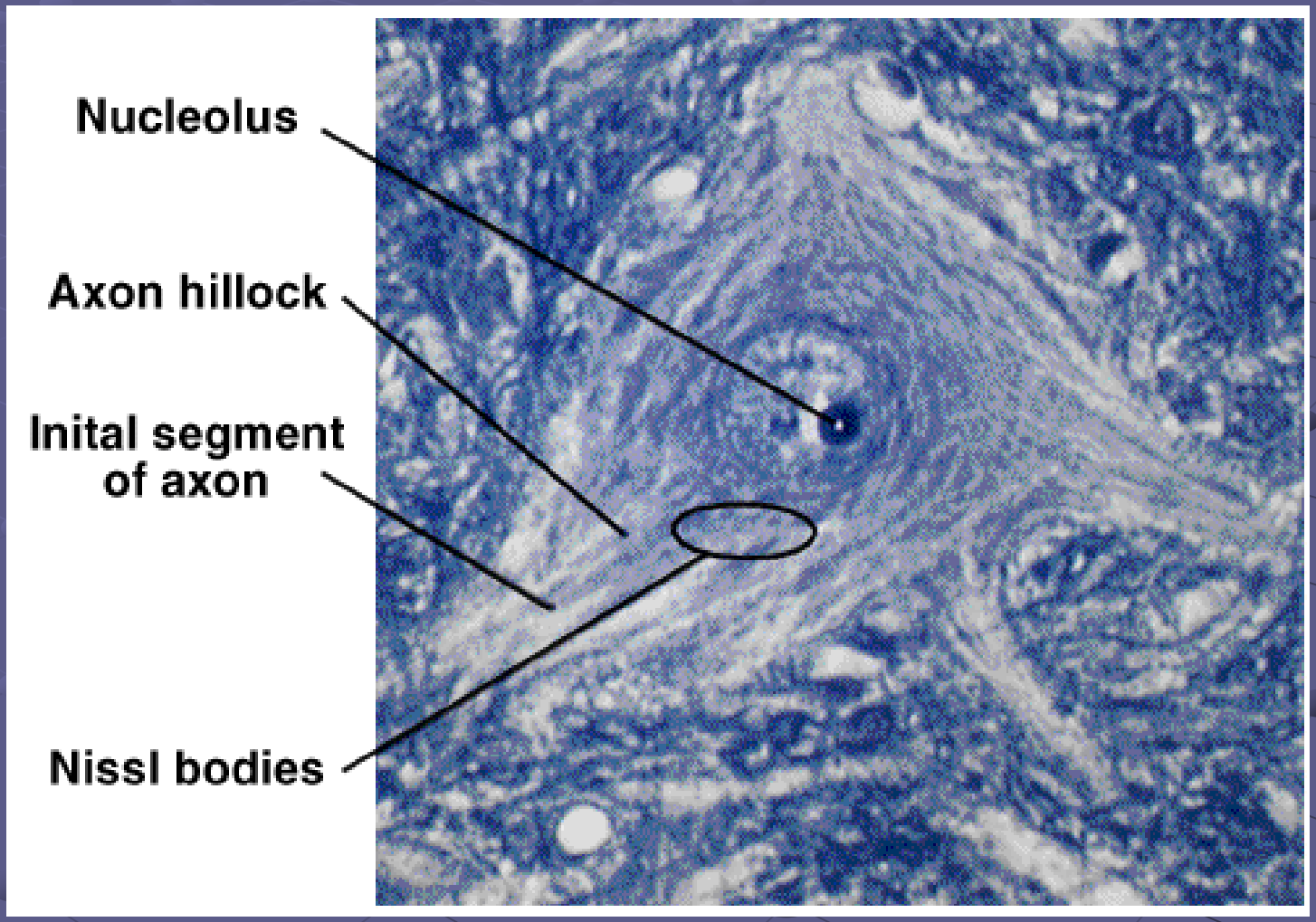


Fig 12.4

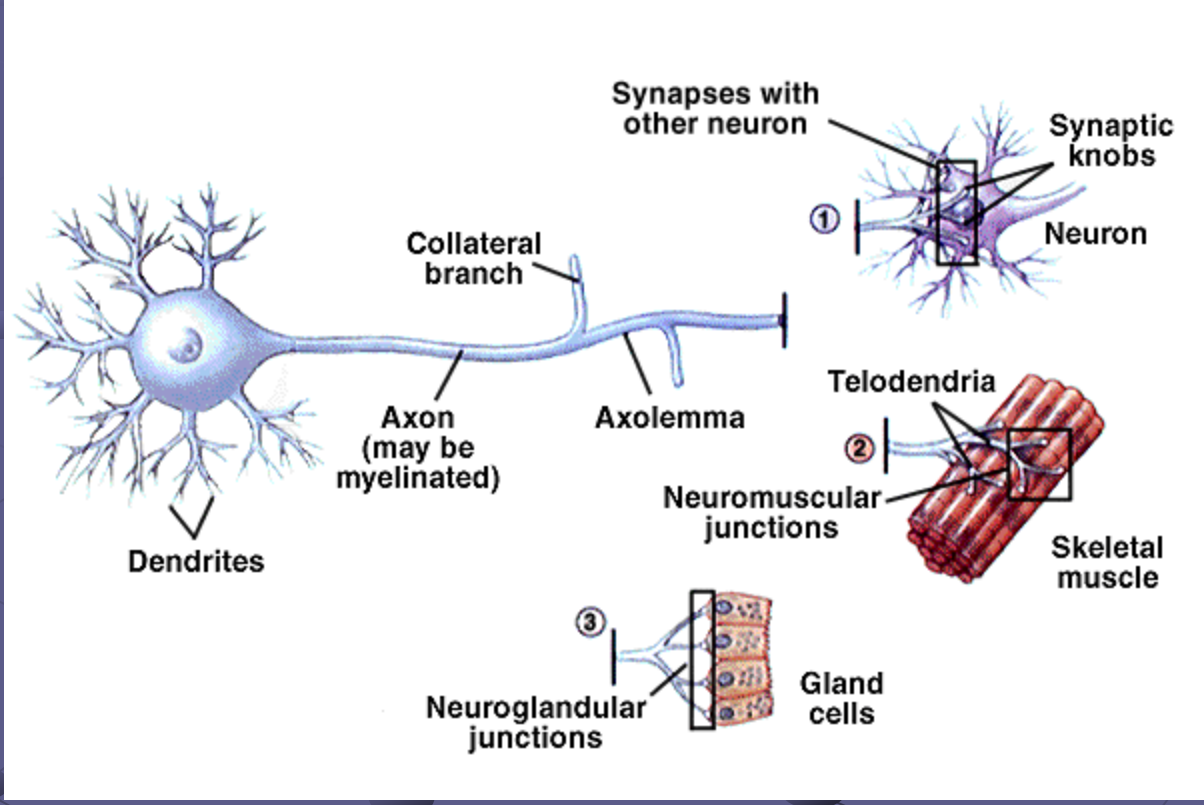
Cell body = Soma




Nucleolus
Axon hillock
Inital segment of axon
Nissl bodies

The “signal,” or Action Potential is carried along the neurilemma

Faster if axon is myelinated



Nerve structure

- A nerve is USUALLY both sensory and motor (axons transmit only in one direction).
  - Some significant exceptions in cranial nerves
- Similar to muscle terminology
  - Epineurium
    - Covers the nerve
  - Perineurium
    - Covers a fascicle
  - Endoneurium
    - Covers an axon

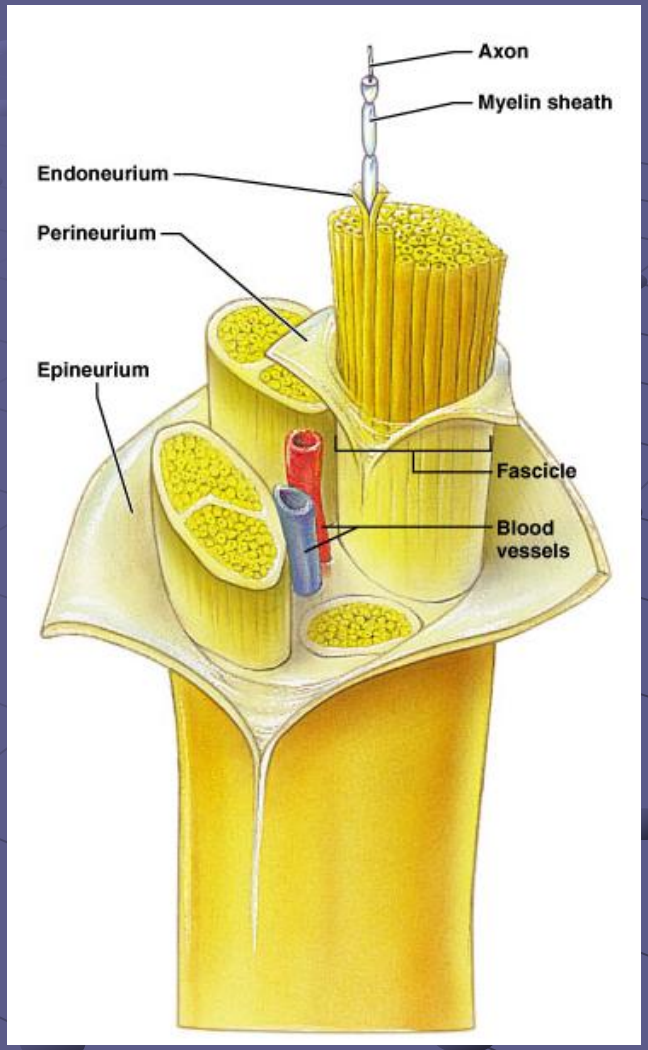
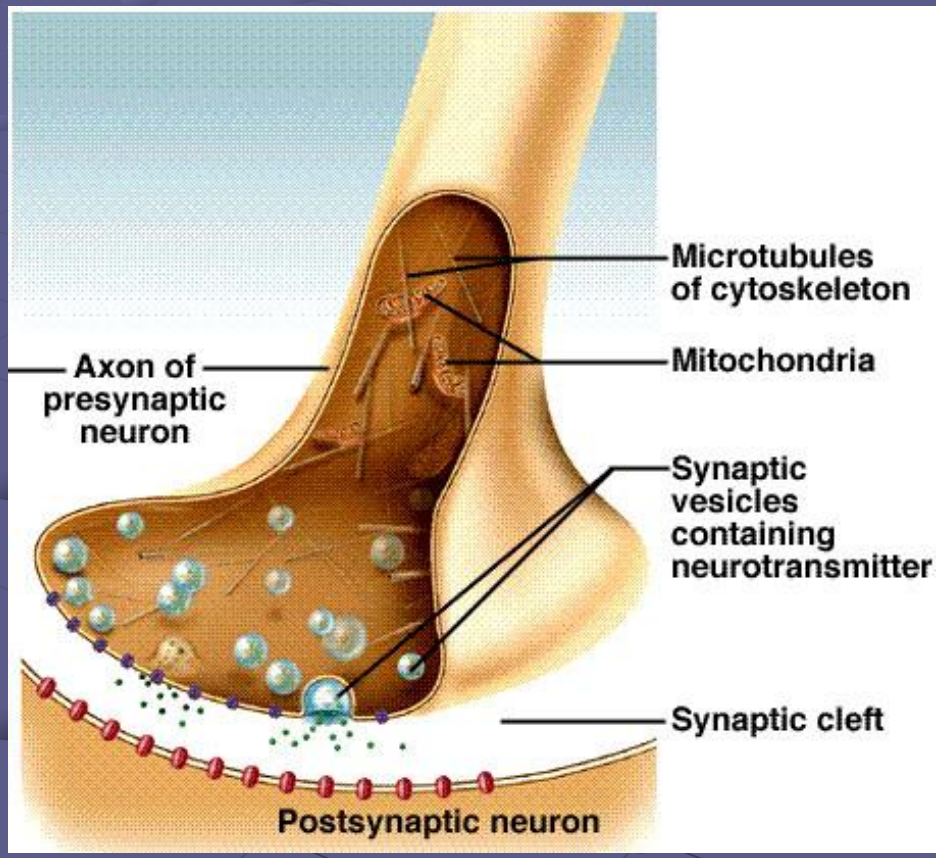


Fig 12.16, p 333

Synapse

- Site of communication between two nerve cells or nerve cell and effector cell
  - Presynaptic and postsynaptic neurons
- neuro-effector junctions, e.g., Motor End Plate
- Electrical vs. chemical synapses



Chemical Synapse vs. Electrical Synapse

Space between two cells

Signal transduction via a neurotransmitter, usually ACh

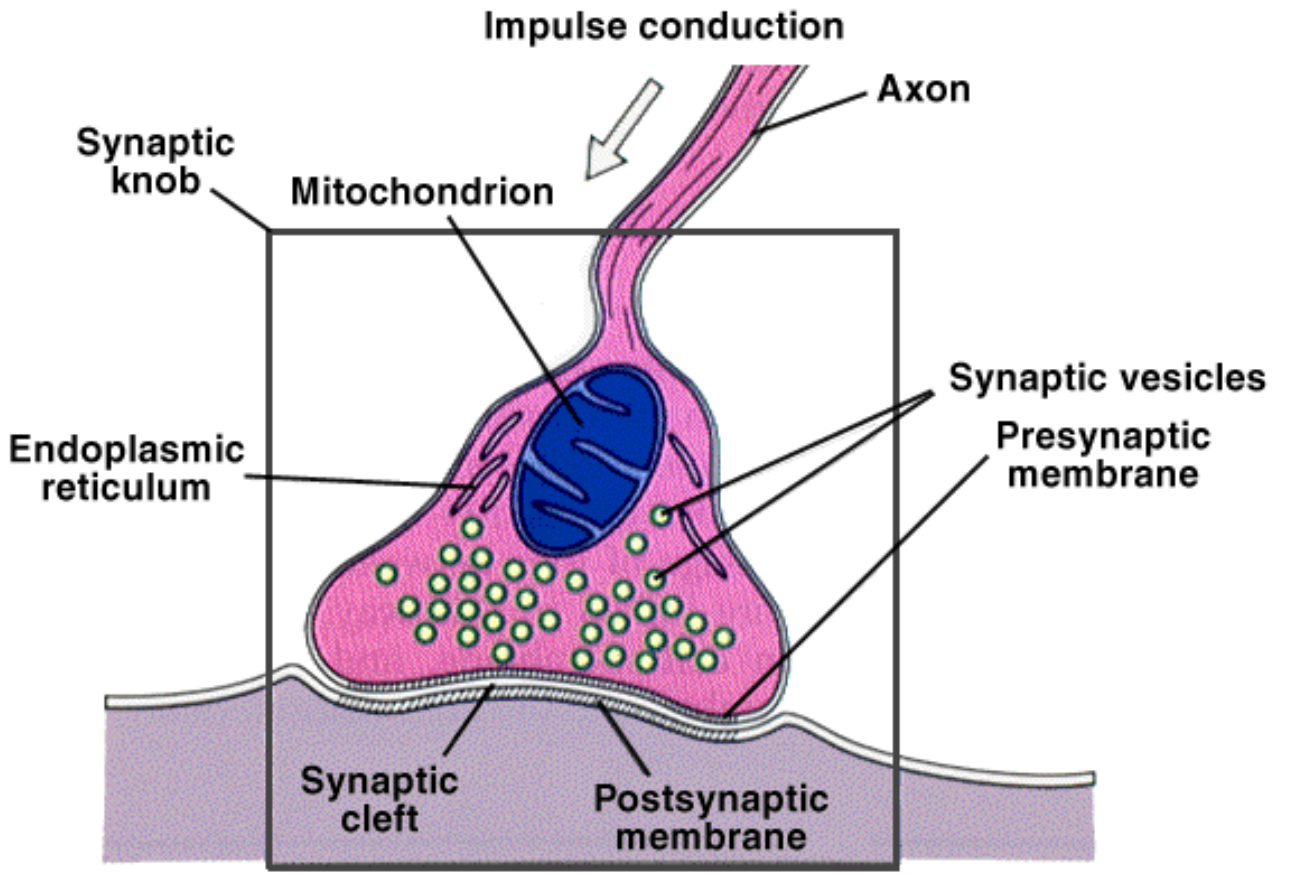
Most common

Direct physical contact between cells = gap junctions

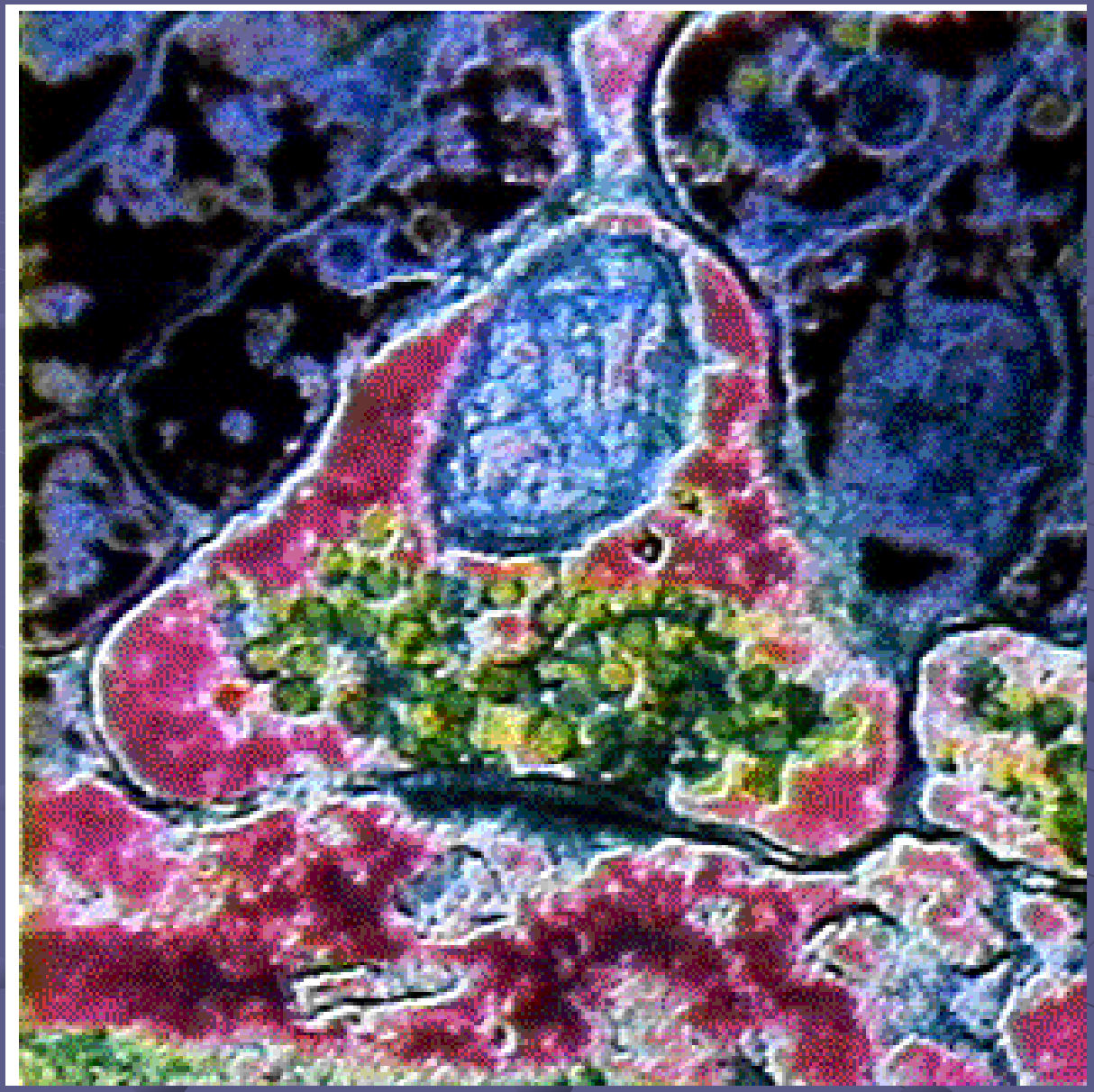
Direct signal transduction

Rare, but occurs in CNS and HEART

Chem. Synapse Structure



1. Axon terminal of presynaptic cell, with vesicles of neurotransmitter(NT)
2. Synaptic cleft
3. Dendrite or cell body of postsynaptic cell
4. Unidirectional



Color enhanced
TEM
x 186,480

Structural Neuron Classification

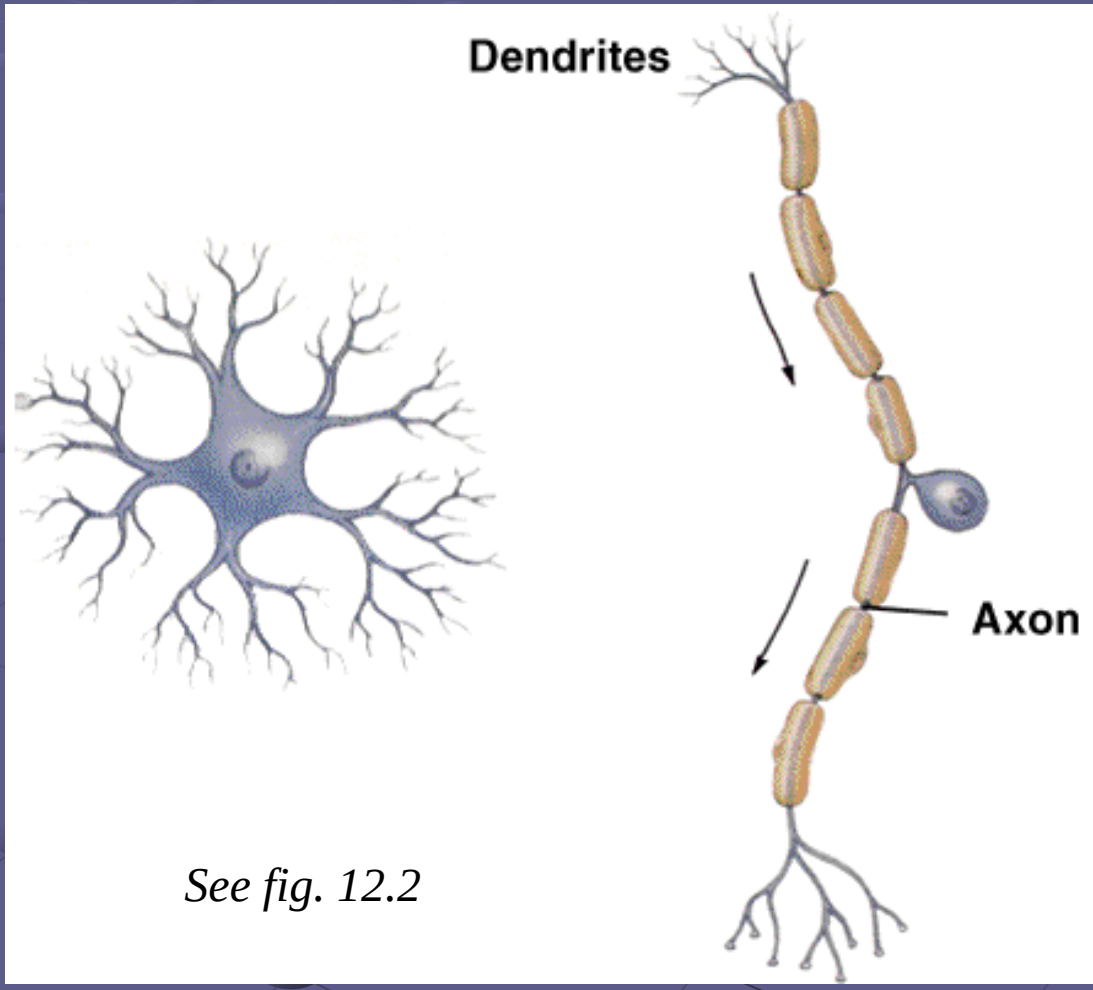
Anaxonic

In CNS and Sense Organs

Unipolar

Also called pseudounipolar

Sensory neurons



See fig. 12.2

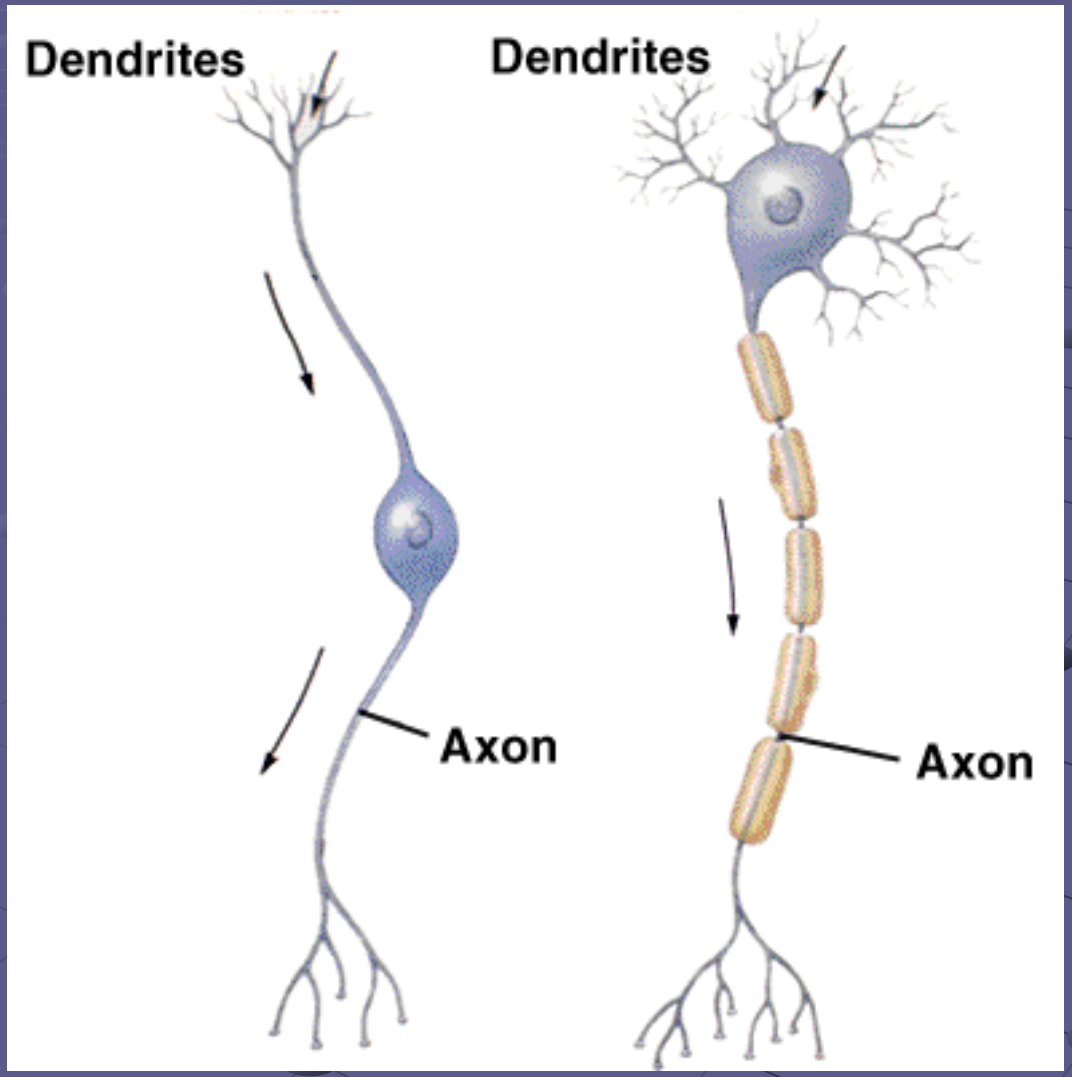
Structural Neuron Classification cont. . .

Bipolar

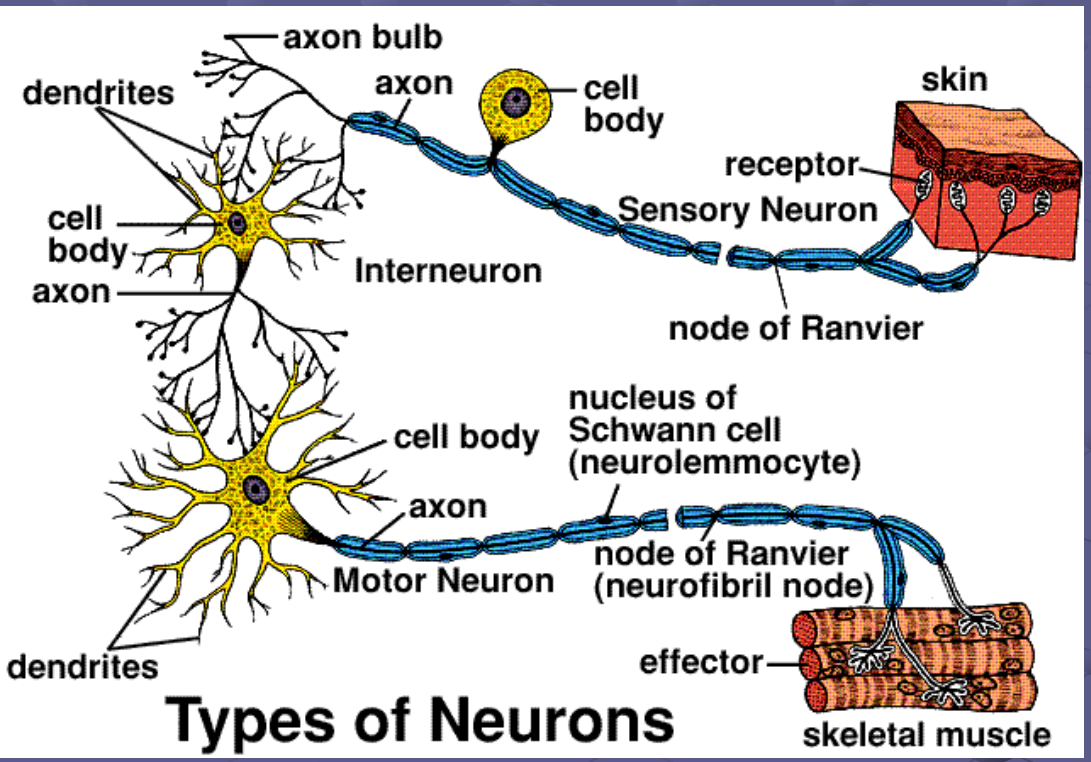
- Unmyelinated
- Rare, but important in special senses

Multipolar

- Most common
- All motor neurons



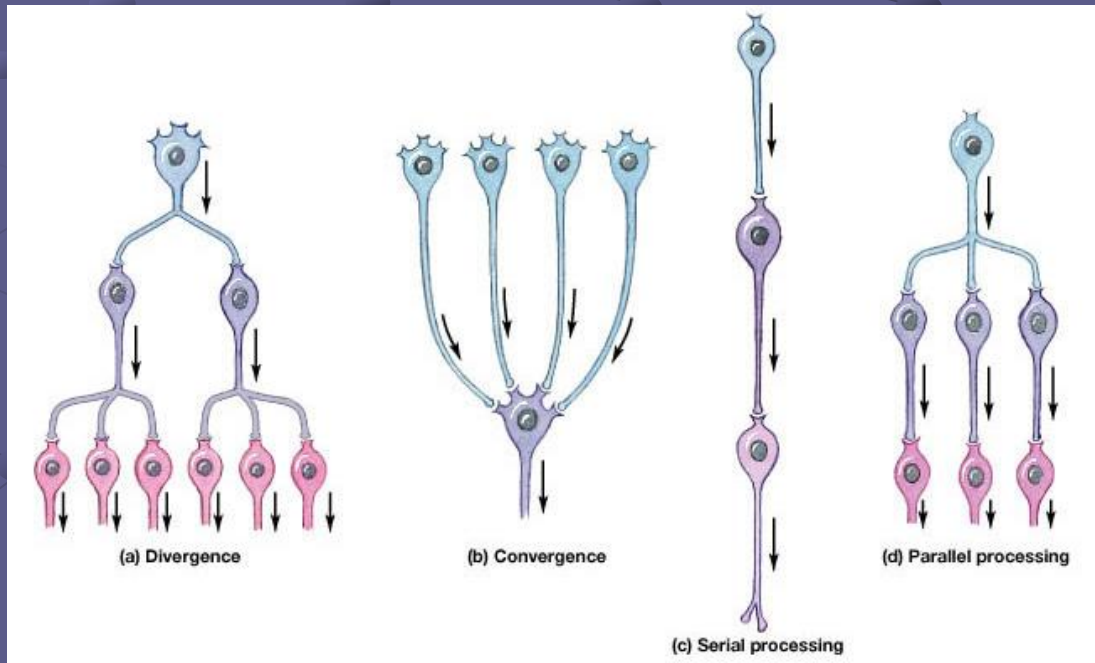
Functional Neuron Classification



1) Sensory (Afferent)
    1) Somatic
    2) Visceral
2) Motor (Efferent)
    1) Somatic
    2) Visceral
3) Interneurons

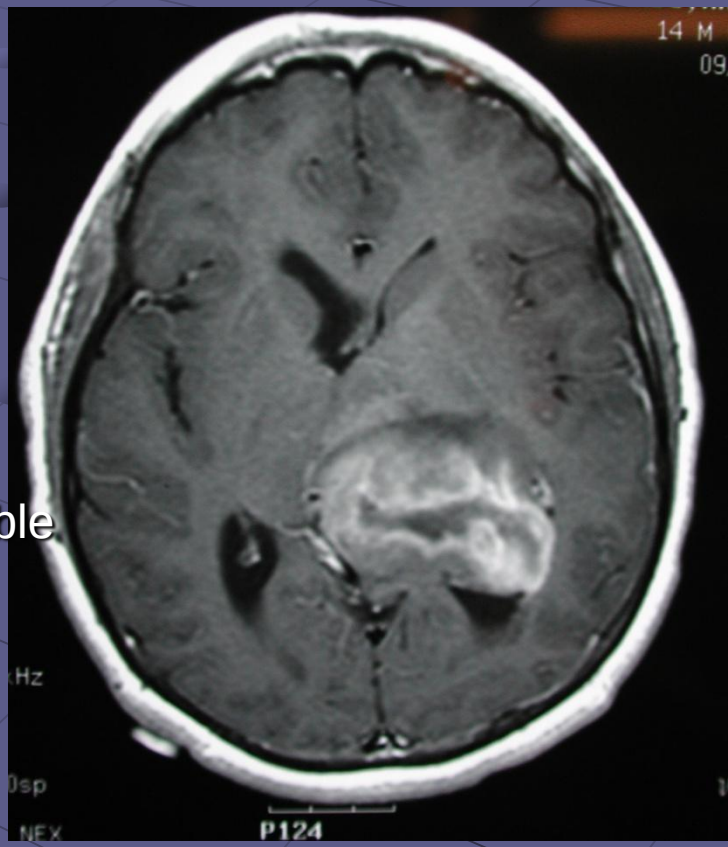
Neuron Organization

- **Divergence -** One neuron synapses with several, effectively "spreading the word".
- **Convergence -** Several neurons synapse with a single neuron, concentrating the input.
- **Serial processing -** step-wise, sequential
- **Parallel processing -** simultaneous processing of different information



2. Neuroglia (glue)

- AKA Glial Cells
- 10-50 X more glial cells than neurons
- Supporting Cells
  Structural and nutritional
- Enhance conduction
  - Schwann cells (neurolemmocytes)
- Ability to divide
  - Think about tumors (malignant glioma)
  - New Information: Some glial cells are excitable

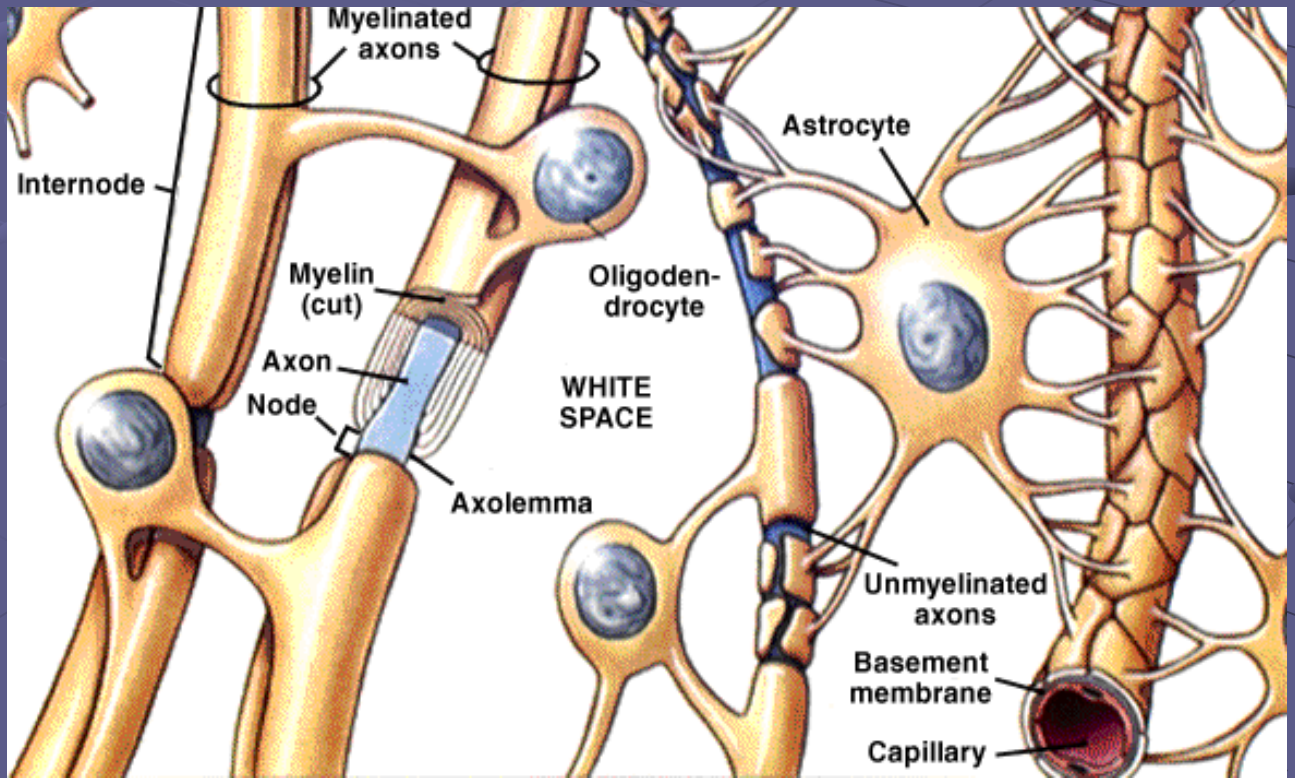


2. Neuroglia (glue), cont'd

- In the CNS:
  - Astrocytes
  - Microglia
  - Ependymal Cells
  - Oligodendrocytes
- In the PNS:
  - Satellite Cells
  - Schwann Cells

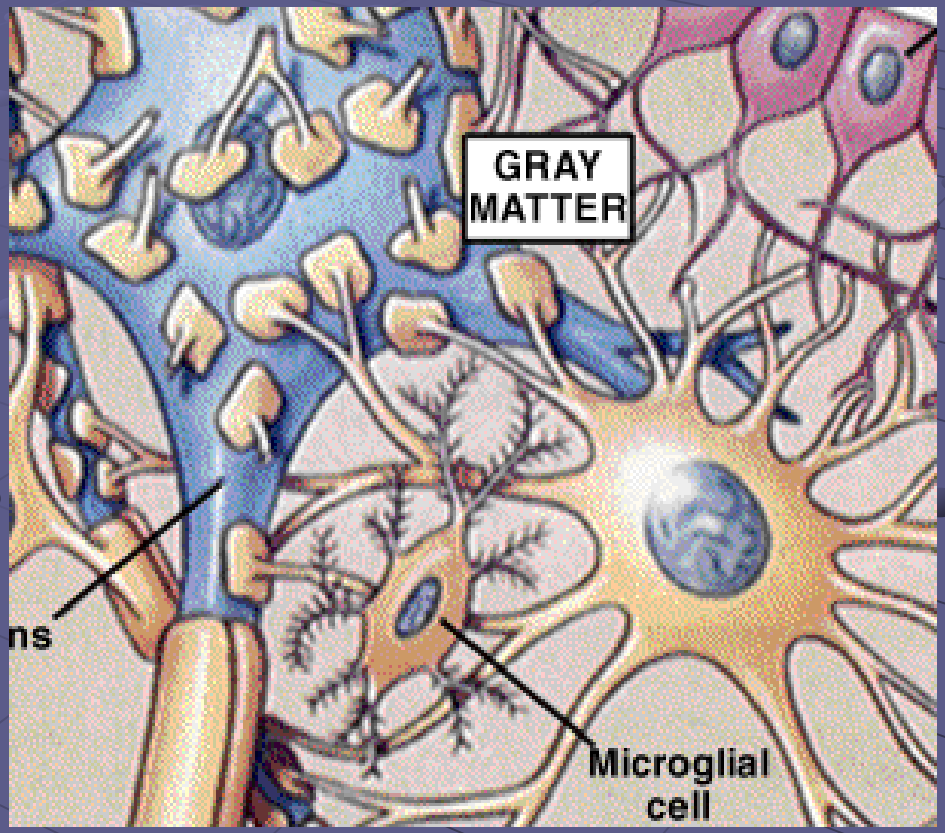
Astrocytes: largest & most numerous

BBB,
control of environment
structural framework & repairs
regulation of ions,and nutrients, gases

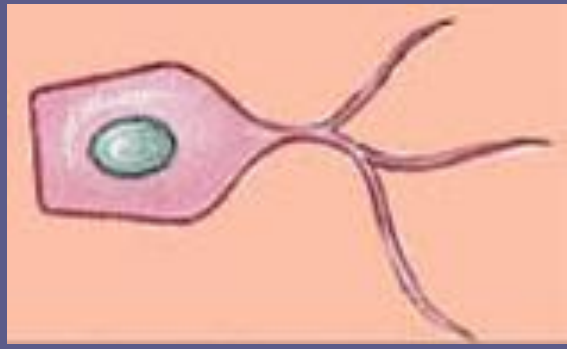


Microglial cells

- Smallest
- Phagocytosis
- ↑ # during infection or injury
- Derived from white blood cells



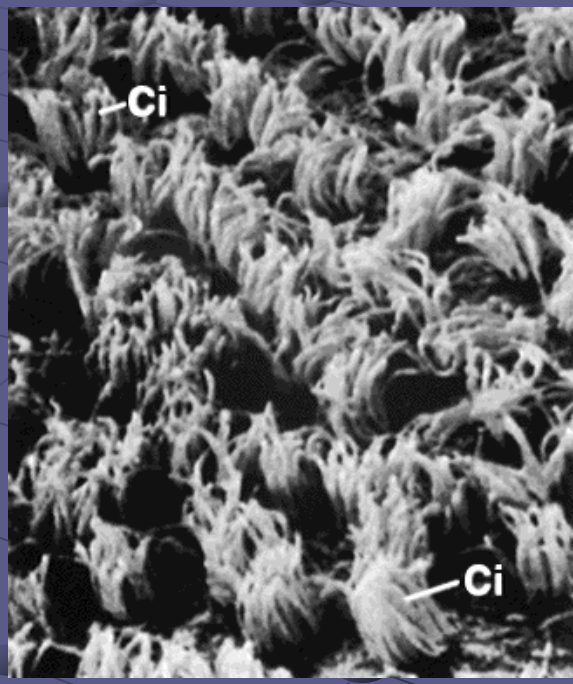
Ependymal cells

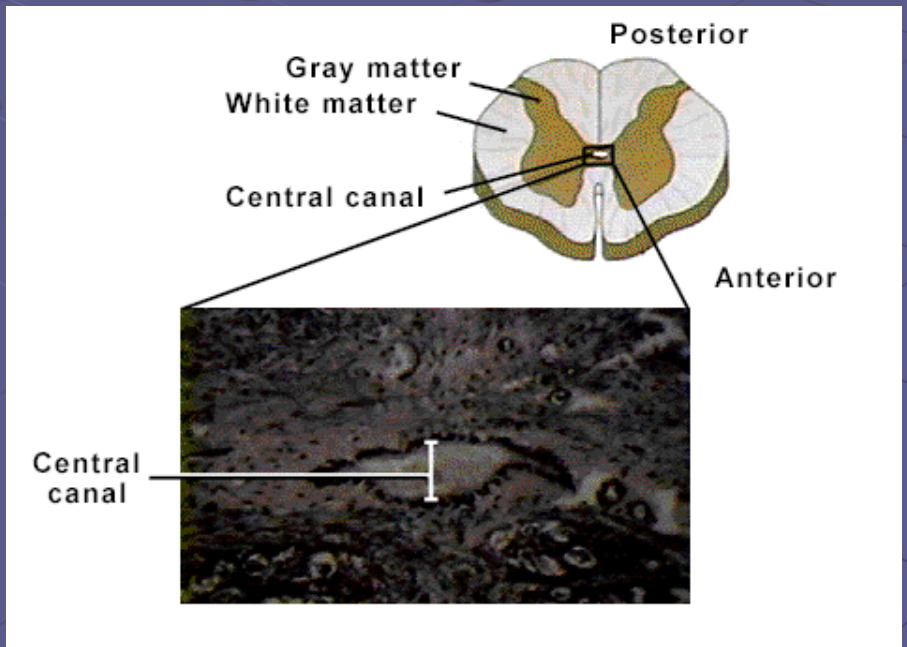


Lining of ventricles & central canal

Some regions ciliated

Some specialized to produce and monitor CSF



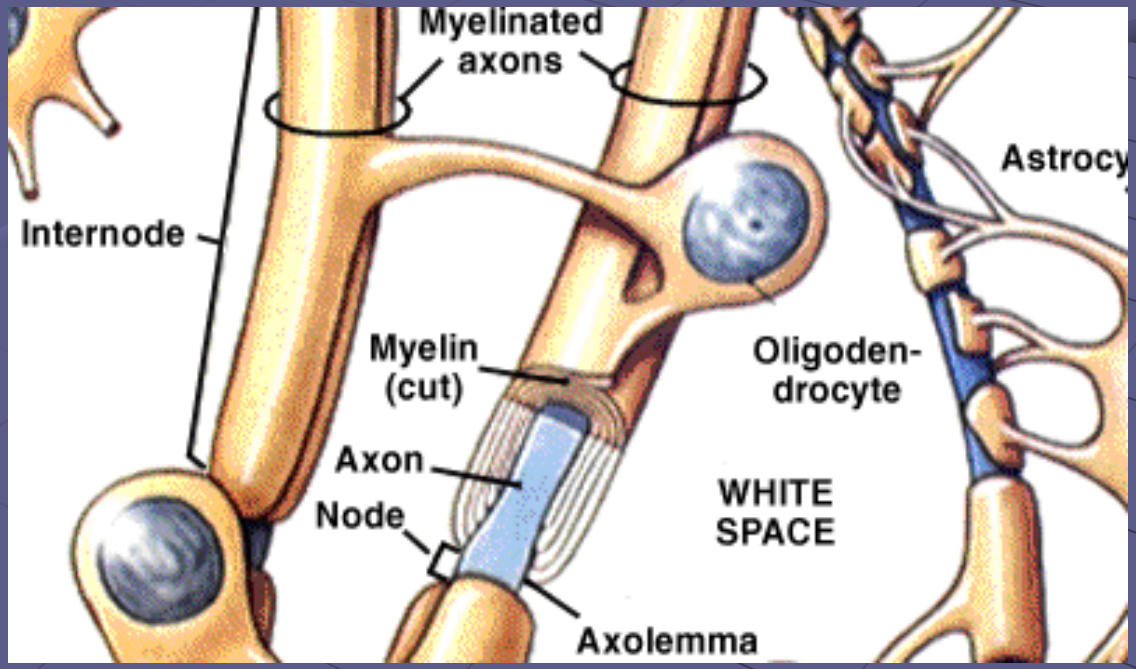


Oligodendrocytes

Smaller than astrocyte

Cover neurons with myelin <u>in CNS</u> *(white matter vs. gray matter!)*

Myelin improves the rate of impulse conduction



The Myelin Sheath p 357

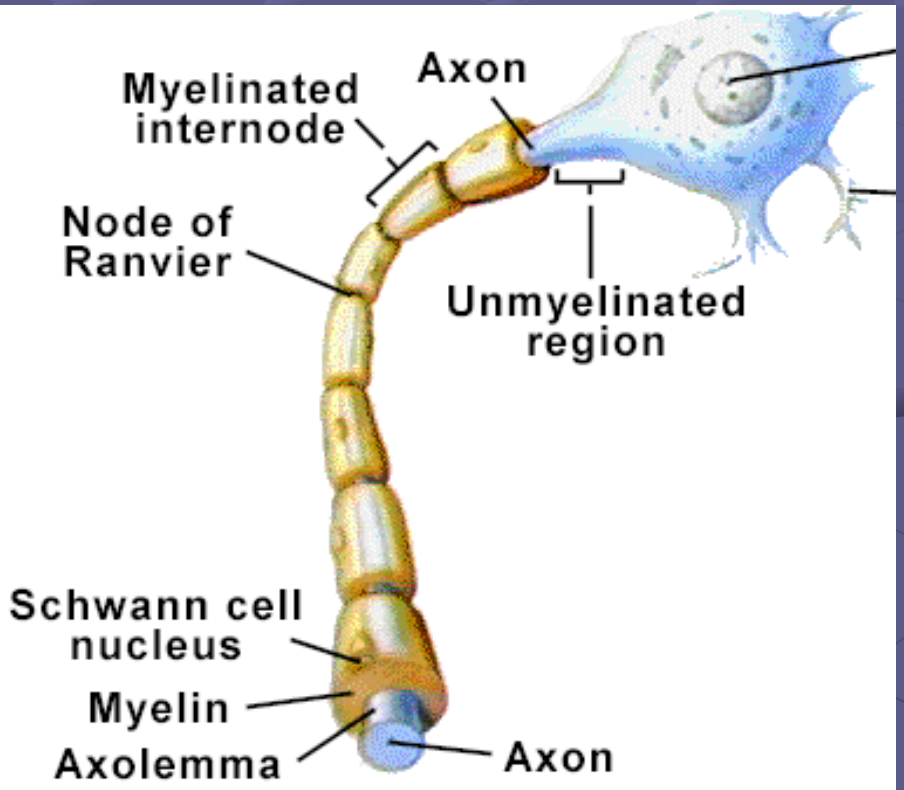
The lipoprotein "myelin" is wrapped around and around the axon in "myelinated nerves."

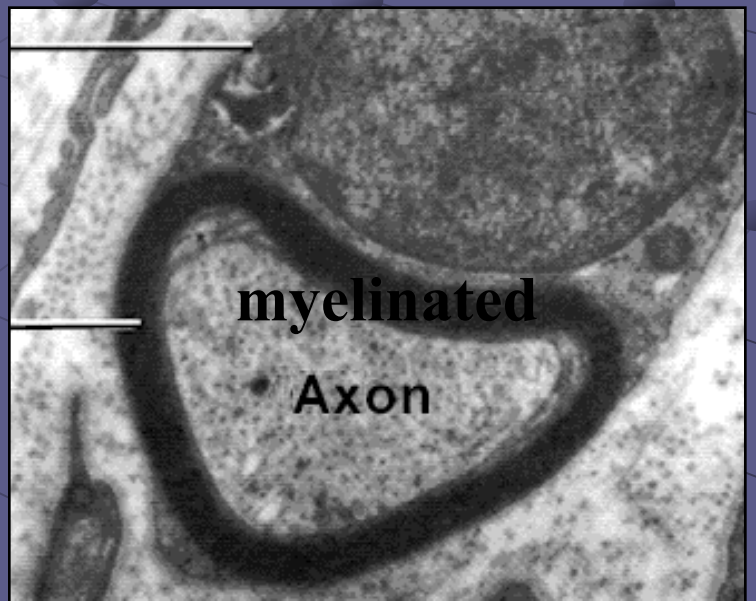
Node of Ranvier = gap between neurolemmocytes

- In CNS:
  - Called oligodendrocytes
- In PNS:
  - Called neurolemmocytes or Schwann Cells

Schwann Cells: AKA neurolemmocytes

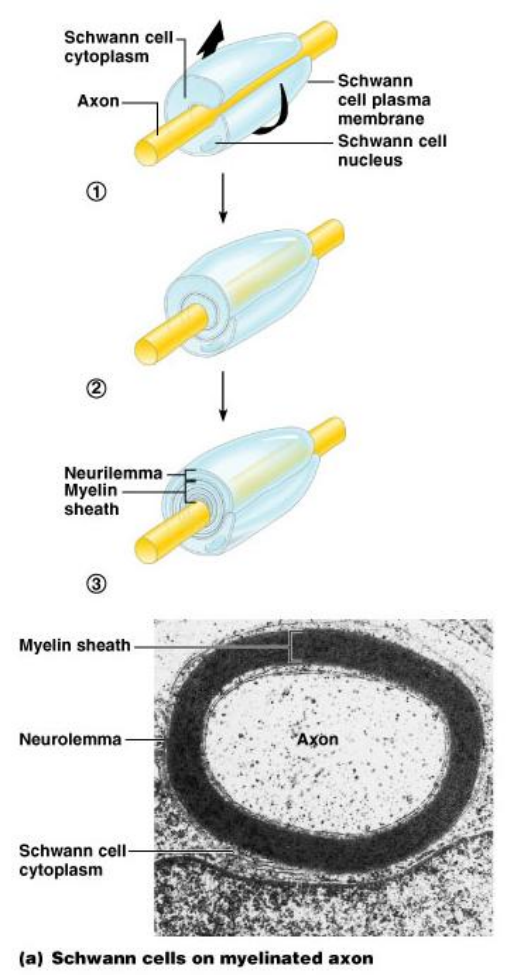
- Surround all peripheral axons!
- Responsible for myelination of PNS
- Involved in repair mechanism after injury Wallerian Degeneration





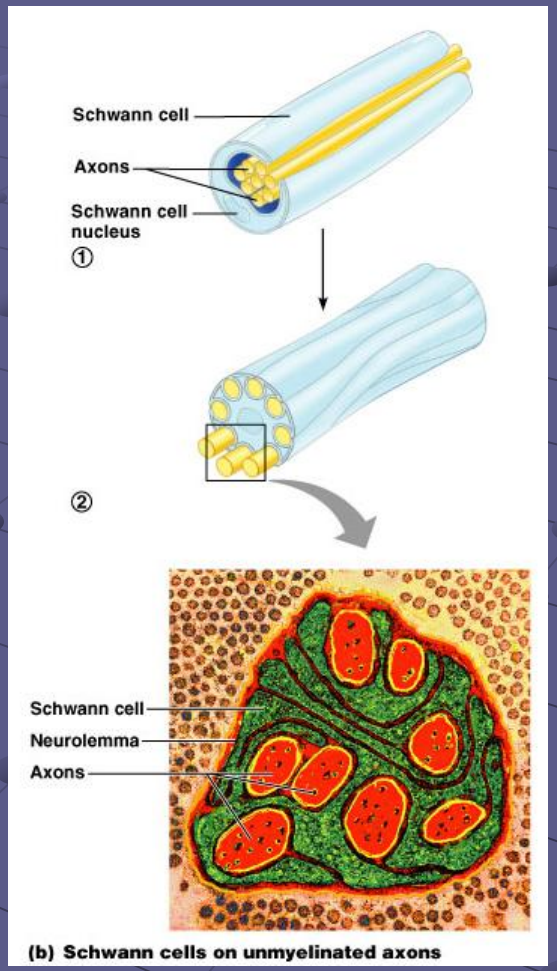
Schwann Cells (in the PNS)

Myelinated



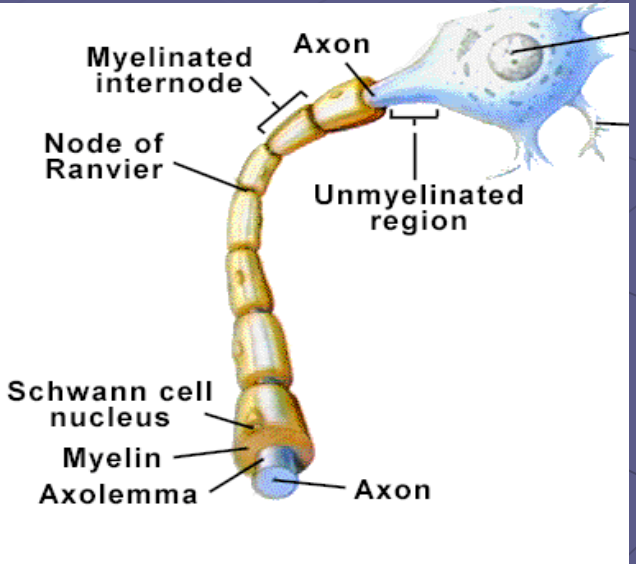
Refer to Fig 12.7

Nonmyelinated



Demyelination

- Multiple sclerosis (p 365)
  - Autoimmune destruction of myelin sheath in the CNS
  - Young adult women
  - Usually idiopathic
  - Genetic?
- Guillain-Barré Syndrome
  - Autoimmune destruction of myelin sheath in the PNS
  - Usually a consequence of an infectious disease
  - Leg weakness



Some Terminology

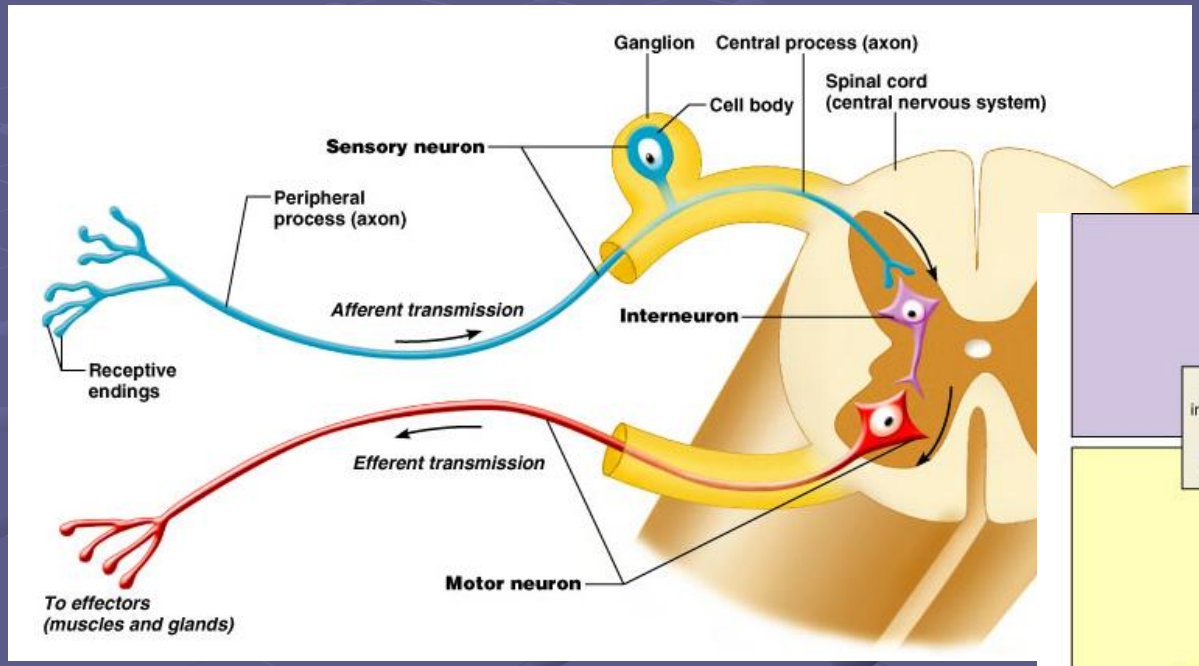
Collections of cell bodies –
- ganglion in PNS
- nucleus in CNS

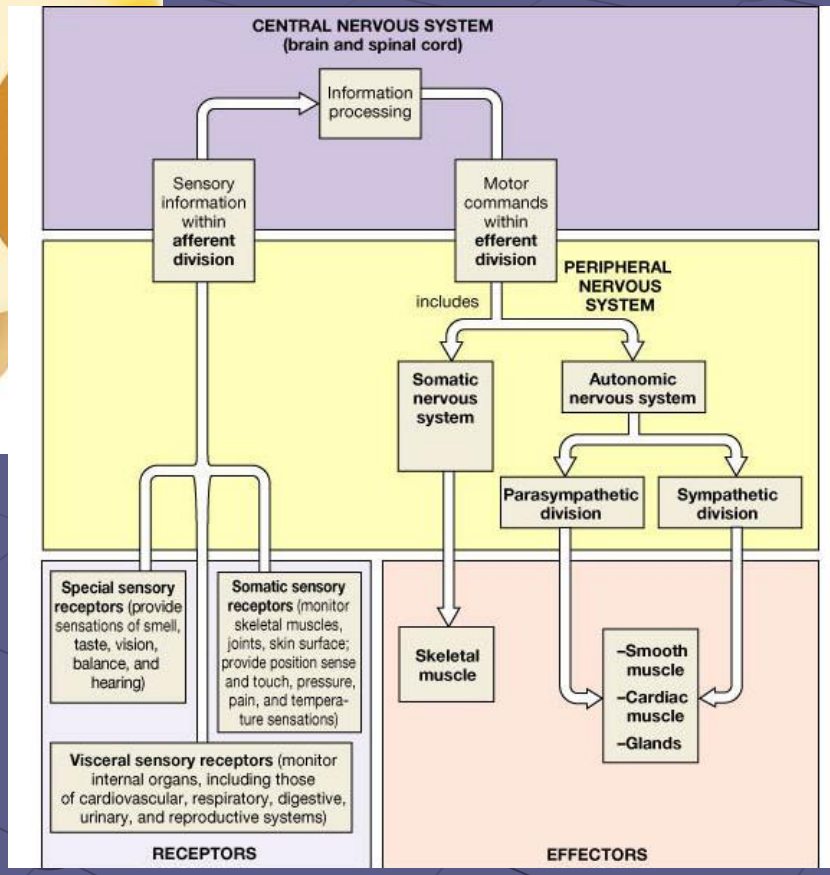
Bundles of axons (or fibers) –
- tracts in CNS
- nerves in PNS

"White matter" = myelinated axons, both nerves and tracts

"Gray matter" = non-myelinated material, dendrites, synapses and cell bodies as well as nonmyelinated axons. In CNS – nucleus; in PNS - ganglia

The circuit fig 12.9

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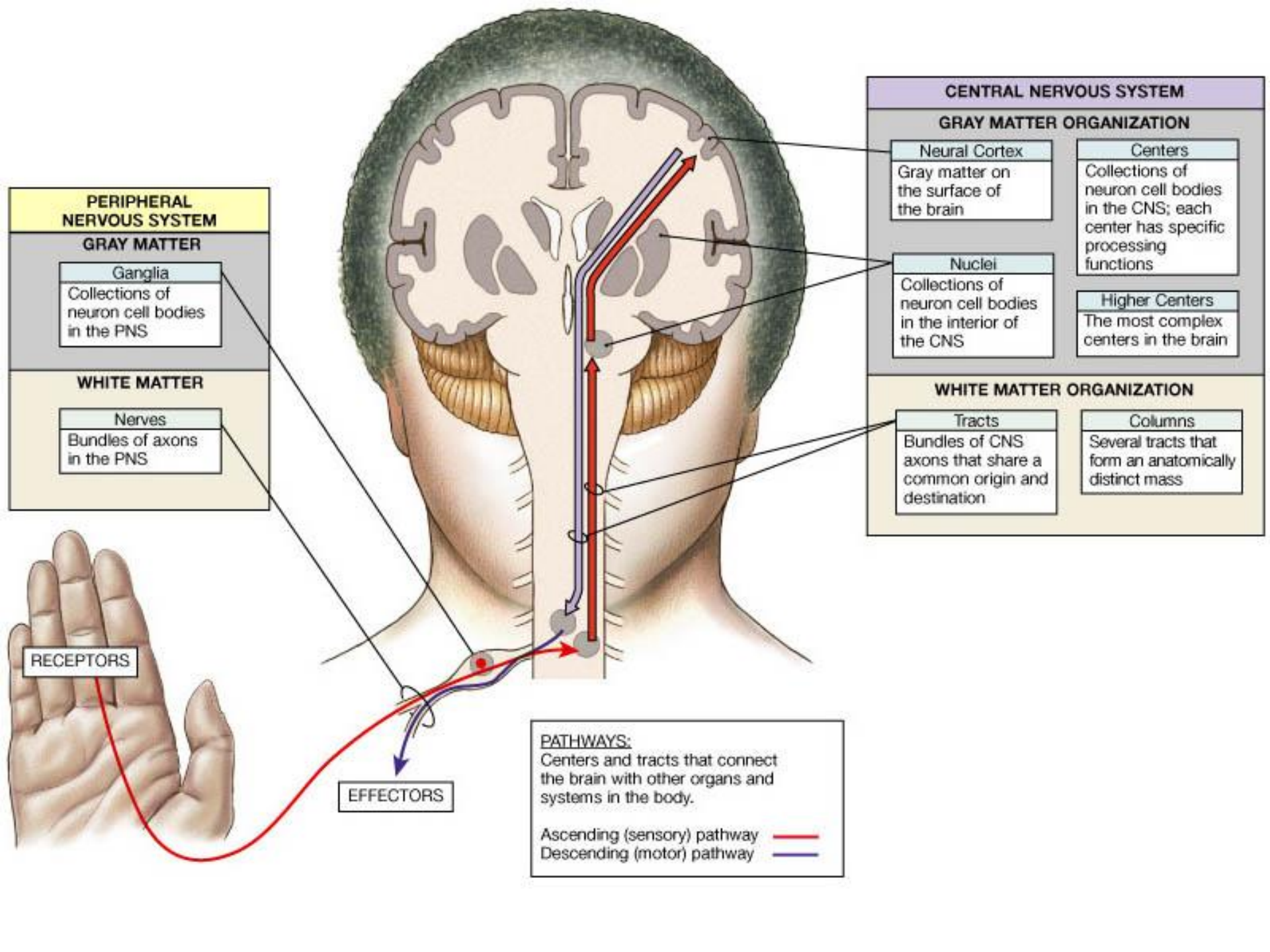
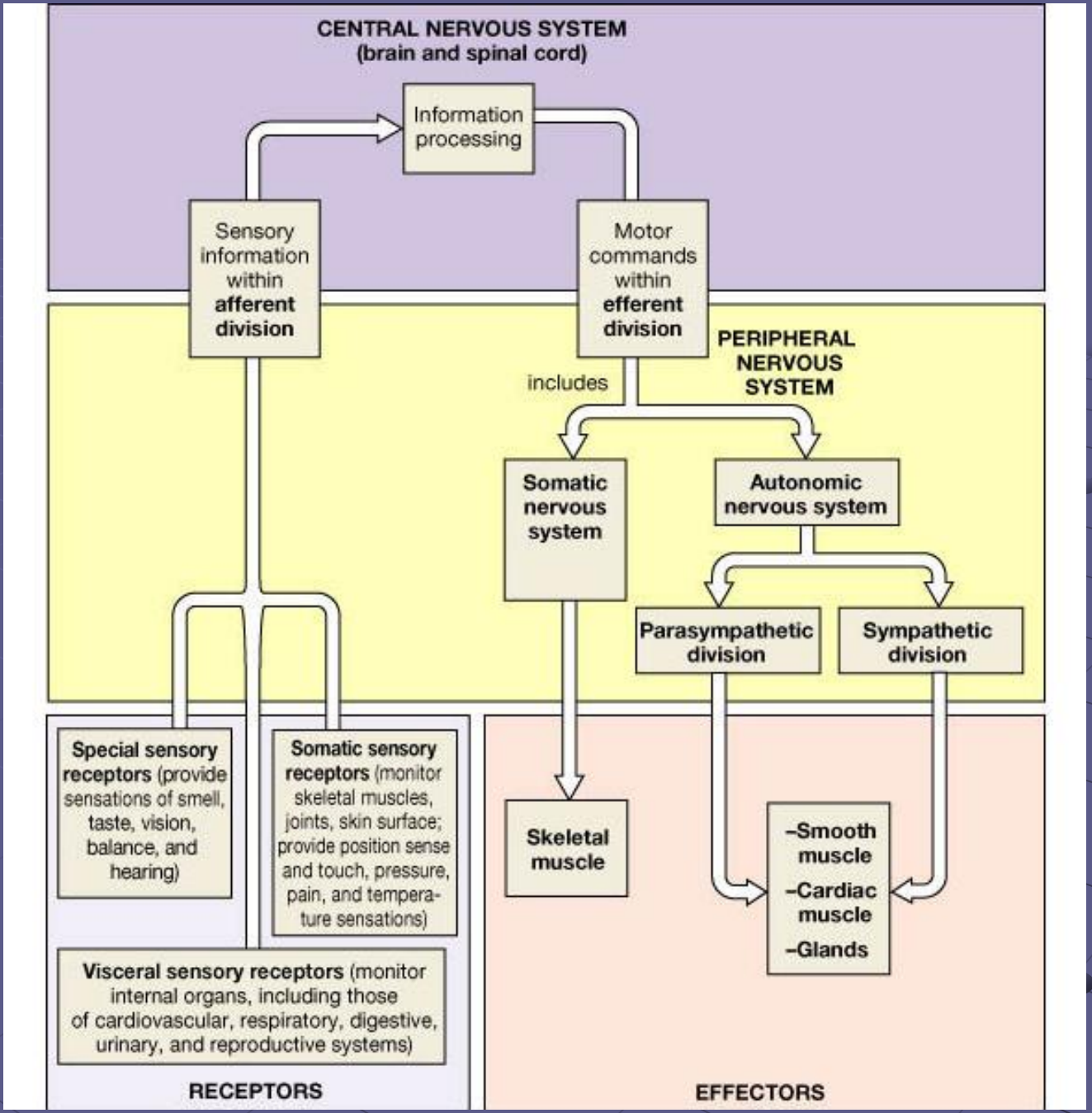

PERIPHERAL NERVOUS SYSTEM
GRAY MATTER
Ganglia
Collections of neuron cell bodies in the PNS
WHITE MATTER
Nerves
Bundles of axons in the PNS
CENTRAL NERVOUS SYSTEM
GRAY MATTER ORGANIZATION
Neural Cortex
Gray matter on the surface of the brain
Centers
Collections of neuron cell bodies in the CNS; each center has specific processing functions
Nuclei
Collections of neuron cell bodies in the interior of the CNS
Higher Centers
The most complex centers in the brain
WHITE MATTER ORGANIZATION
Tracts
Bundles of CNS axons that share a common origin and destination
Columns
Several tracts that form an anatomically distinct mass
RECEPTORS
EFFECTORS
PATHWAYS:
Centers and tracts that connect the brain with other organs and systems in the body.
Ascending (sensory) pathway
Descending (motor) pathway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